

experiments should demonstrate the metabolic conditions in such limbs and the permanent results of the operations.

If these permanent results are possible, if no trophic troubles occur, and if the functions of the transplanted or replanted limb are satisfactory, then it will be legitimate to employ similar operations in human surgery. Of course it is a mere suggestion at present, and further investigation may show that it is quite impossible.

We are very glad to thank Dr. Stewart for giving us the privilege of performing these experiments in his laboratory.

TETANY: A REPORT OF NINE CASES.

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ESCHERICH distinguishes two main clinical varieties of tetany. First, an *intermittent* form in which the muscular spasms disappear and only those latent symptoms associated with laryngospasm are present—*e. g.*, tetany of rickets. Secondly, a *persisting* form in which the contractures predominate and last for days or even for months. The irritability of the nervous system, however, is much less pronounced, so that latent symptoms may eventually be entirely absent. This latter group also includes the affections: (a) *flexibilitas cerea*, where the entire body is in a state of tonic, wax-like rigidity; (b) *arthrogryposis*, where the hands and feet only are affected; (c) *pseudotetanus*, in which the trunk and legs are affected.

Most authorities are now agreed that "carpopedal" spasm and "laryngismus stridulus" are manifestations of tetany in children.

Following Frankl-Hochwart's classification, we have grouped our cases into: 1. Tetany of gastric origin, of which we have six examples. 2. Tetany of intestinal origin, of which we have but one example. 3. Tetany of childhood, of which we report two illustrations. With one exception (Case V) we have not included cases from the Medical Dispensary. A case of tetany complicating pregnancy, which was in the wards, has been reported at length by Dr. H. M. Thomas²⁵ and will be only referred to here. One other case, diagnosed as tetany, has been purposely omitted, as the presence of a marked hysterical element and the absence of the secondary phenomena do not warrant its inclusion in this paper.

CASE I. *Gastric ulcer (?)*; *hyperacidity*; *hypersecretion*; *tetany*.

C. K., aged forty-six years; male; white; German; laborer. Hospital No. 36910. Admitted November 8, 1901. Complaint, stomach trouble.

Family History. Negative.

Previous History. He had stomach trouble for thirteen years. He denied venereal disease. He had drunk one to two quarts of beer a day for the past fifteen years.

Present illness began one year ago, November 1, 1900, with severe burning pain in the stomach, which was continuous night and day and was not affected by food. He vomited after meals nearly every day. In January, 1901, while at stool, he vomited almost a bucketful of blood. Hæmatemesis did not recur. He had lived on milk and eggs and small amounts of wheat bread since March, 1901.

Physical examination was negative. On November 11th he vomited large quantities of very acid clear mucoid material. At the end of the vomiting there was spasm of the muscles of the hands and feet and slight spasm of the muscles of the trunk. He was conscious, but was emotional. Following the removal of the test breakfast he had a similar, much less marked attack. Gastric analysis showed total acidity 70, total free HCl 65, and absence of lactic acid. Microscopic examination was negative. The passage of the stomach tube during the intervals of digestion revealed large quantities of clear material, showing marked hyperacidity on several occasions. The temperature ran a normal course. Pulse ranged from 76 to 112.

On November 28th the patient was discharged, his weight on discharge being 197½ pounds.

He was readmitted on February 24, 1902, for "stomach trouble."

His second illness began on February 15, 1902, when, after working a short time he began to vomit repeatedly until February 20th, since when he had only vomited once. He had two attacks of tetany during the paroxysms of vomiting, one on February 20th, confined to the hands, during which he was unable to straighten his fingers. On this date he had to stop work from weakness. Weight on this admission 177 pounds.

Physical examination was negative, except for the presence of fairly numerous sonorous piping rales throughout both lungs, and the area of gastric tympany was considerably increased. The facial and Trousseau's phenomena were negative. Red blood corpuscles, 5,516,000; white blood corpuscles, 9000; hæmoglobin, 95 per cent.

On February 25th he had a violent vomiting attack, followed by a paroxysm of tetany of the upper and lower extremities, and facial muscles, and the platysma. During the attack, which lasted seven to nine minutes, he complained of great pain in the abdomen. Following this the patient looked ill, the tongue was coated and the breath foul, but the area of gastric tympany seemed normal. An analysis of the vomitus showed a total acidity of 94 and a total free HCl of 74.

On February 28th a great irritability to the galvanic current was

noted. With the cathode over the ulnar nerve tetany was induced with a very feeble current of about 3 milliamperes.

The urine examination was always negative. The temperature curve ranged from 97° to 100° and the pulse, which reached 120 during the day of the attack, usually ranged from 76 to 100. During his stay in the hospital he was in a curious nervous state, being very emotional, excitable, and difficult to control. Somewhat improved, and weighing 175 pounds, he insisted upon going home on March 5, 1902.

The patient returned in March, 1905, in answer to a letter. He had been free for three years from all the symptoms of both tetany and hypersecretion. He had regulated his bowels and was in perfect health.

CASE II. *Dilatation of the stomach; tetany.*

E. C. B., aged twenty-four years; male; white; German. Occupation, rattanner. Hospital No. 37166. Admitted December 4, 1901. Complaints: "indigestion and cramps in the hands."

Family History. Negative.

Previous History. Negative except that for four weeks in the summer of 1900 he had pain after eating, which was relieved by medicines.

Present illness began in July, 1901, with pain after eating and occasional diarrhoea, which continued up to his admission. On November 20th he had the first attack of cramps in the hands and feet preceded by a tickling sensation in the legs from the knees to the feet. The hands were stiff and straight. After this attack he had five or six others. He stopped work in June, and remained in bed all August and September. On December 3d he had the severest attack and was brought to the Medical Dispensary. In this attack his hands were "drawn up" for the first time. The pain in the stomach gradually improved. There had been no nausea and no vomiting. He had on an average two to four movements a day. He had lost thirty pounds in weight.

Upon *physical examination* the patient was emaciated, sallow, and looked ill. The gums were pale; the tongue was lightly coated. The pupils were equal and active. The area of gastric tympany was considerably increased, without inflation reaching to the fourth intercostal space in the midaxilla, measuring 24 by 18 cm. After inflation the greater curvature extended well below the umbilicus. There was no visible peristalsis and no palpable mass. There was marked mechanical and electric irritability of both hands and feet—Trousseau's phenomenon being elicited by compression of either the brachial or femoral artery. On pinching the biceps a tetanic contraction lasting several seconds was induced. With a galvanic current of 2 milliamperes there was a typical spasm of the hands when the brachial plexus was stimulated; a current of 6 milliamperes to the brachial plexus caused a spasm of both the legs

and the arms. There was spasm of the facial muscles on weak stimulation of the seventh nerve. A very weak faradic current produced a general tetany of the arms and legs. Red blood corpuscles, 2,460,000; white blood corpuscles, 3600; hæmoglobin, 50 per cent.

On December 9th Dr. Thomas noted that the hands were free from spasm, and that there was slight fibrillary tremor in the intrinsic muscles of the hands. Strong muscular effort, however, caused spasm; and the facial and Trousseau's phenomena were both perfect.

On December 7th a test breakfast showed a residue of 110 c.c., a total acidity of 56, and free HCl 21. Microscopic examination was negative.

On December 10th during gastric lavage the patient had a general spasm, involving the face muscles as well.

The urine examination showed on two occasions a faint trace of albumin. The temperature ran a normal course. The pulse was 88 to 92 to the minute. His weight on December 9th was 101½ pounds. On December 10, 1901, he was discharged at his own request, unimproved.

His physician, Dr. John Girdwood, reported that after the patient had left the hospital the facial phenomenon continued for a long time. The tetanic spasm recurred in June, 1902, though in a milder form. The gastric pain, nausea, and vomiting also recurred periodically. He became unable to retain solid food; anæmia became more pronounced, and he died on April 17, 1903, eighteen months after his discharge.

CASE III. Dilatation of the stomach; hyperacidity; tetany.

G. W. S., aged fifty-two years; male; white; American; occupation, manager of foundry. Hospital No. 43203. Admitted June 27, 1903. Complaint: "pain in the back of the neck and sides; stomach trouble."

Family History. Negative.

Previous History. Negative.

Present Illness. For the past ten years he had been feeling out of sorts, with a dull, frontal headache and pain in the eyes, a bad taste in the mouth, loss of appetite, and constipation. There had been occasionally slight pain in the stomach. He had not vomited except with "car-sickness," to which he was very liable. He had some belching of gas, but no hæmatemesis.

Physical examination revealed some emaciation. There was no enlargement of the thyroid gland. The heart and lungs were clear throughout. The abdomen appeared natural except for marked clapotage. After inflation of the stomach the abdomen became prominent from the midepigastrium to the umbilicus. There was slight visible peristalsis. The area of tympany measured 23 by 17 cm. and extended upward to the seventh rib in the midaxilla, and

to the right as far as the mammary line. No masses were felt. The knee-jerks were normal.

On July 1st the test breakfast revealed a total acidity of 66; total free HCl 54. Only 30 c.c. were removed. Microscopic examination was negative. At the end of the lavage the patient felt faint, looked pale, and had to be supported. Suddenly both arms began to twitch and were brought across the chest, overlapping each other. The hands were flexed at the wrist, with the fingers flexed at the proximal joints and extended at the distal. The attack lasted only a few seconds. The feet were not observed.

The urine examination showed a faint trace of albumin on two occasions. The temperature ran a normal course. The pulse ranged from 60 to 84 a minute. He was discharged improved on July 1, 1903.

CASE IV. *Pyloric stenosis; dilatation of the stomach; tetany; death; autopsy.*

D. K. N., aged fifty-eight years; male; white; American. Hospital No. 49558. Admitted January 15, 1905. Complaint: "stomach trouble."

Family History. Negative.

Previous History. In his youth he had pain in the region of the navel with vomiting, which afforded relief to the pain. There had never been hæmatemesis or jaundice. In 1890 he had an attack of Bell's paralysis on the left side of the face, following exposure to a draught.

Present illness began four or five years ago, with a sour stomach after meals. He would induce vomiting with almost immediate relief. The vomitus was large in amount, but never contained any blood. He began to use the stomach tube three years ago, since which he had used it regularly every night, removing very large quantities of sour, undigested food. Before he began the use of the stomach tube he had several attacks of cramps "all over the body." These, which he termed "congestive chills," were exceedingly agonizing in character, but were never accompanied by fever or jaundice. In illustrating the attacks he imitated exactly the "obstetrical hand." During one such attack he was thought by his physician to be dying. In none had he lost consciousness. Since beginning the use of the stomach tube he had never had an attack. He gradually lost 25 pounds in weight. In November, 1904, he consulted Dr. Osler, who made a diagnosis of pyloric stenosis, and recommended surgical treatment.

Physical examination was negative except for the abdomen. The latter presented a remarkable picture, with marked prominence in the middle zone, especially just to the right of the navel. The epigastrium was hollowed out. Quite large waves of peristalsis were seen passing from left to right, most marked in the umbilical region. No definite mass was made out, though on one examination

the pylorus was thought to be felt. The stomach lay obliquely in the abdomen and measured about 14 by 34 cm. on percussion. There was marked clapotage. After inflation the waves of peristalsis were a little more active, and the area of gastric tympany measured 15 by 36 cm.

Upon the passage of the stomach tube four hours after the evening meal, 1500 c.c. of residue were withdrawn. This on standing separated into three layers: a frothy upper, a middle liquid, and a lower solid layer. The odor was sweetish, and suggested fermentation. Free HCl was present, but lactic acid was absent. On microscopic examination large numbers of sarcinæ were found. A test breakfast after a gastric lavage the previous night, revealed a total amount of 460 c.c., a total acidity of 40; free HCl 10. Microscopic examination was negative, except for numerous sarcinæ, yeast cells, starch, and an occasional red cell.

He did very well for a few days and was allowed to move about at will. On the morning of January 21st the patient complained of some discomfort in the stomach and numbness in his hands. During the day of the 22d he used the stomach tube, with temporary relief. During the night of the 22d he was awakened by discomfort in his stomach and he again used the tube. Immediately after the lavage he complained of a severe pain in all the extremities, and he awakened the ward with his shrieks. At 2.15 A.M. (fifteen minutes after the onset) the patient was seen by me in a most pronounced tetanic spasm of the upper and lower extremities, as well as of the facial muscles. The spasm was most marked in the right side of the face. All the muscles of the extremities were rigidly contracted, with the appearance of the typical obstetrical hand and carpedal spasm. The neck and trunk muscles seemed uninvolved. The pulse was rapid; the heart beat violently; the face was bathed in sweat; there was little or no dyspnoea. While the spasm was constant, at repeated intervals it became more intense and the patient would shriek with pain in spite of opiates. There was suppression of urine, clouding of the mind, marked cyanosis of the face, especially of the tongue and a very marked condition of mechanical irritability. The slightest pressure over the nerve or the artery increased the condition. There was slight twitching of the muscles of the face and the upper extremities. The blood count on the 23d revealed: red blood corpuscles, 4,056,000; white blood corpuscles, 17,480; hæmoglobin, 70 per cent. During the 23d his condition gradually grew worse. The muscular irritability became extreme. The slightest touch to the abdomen or the extremities, or even knocking against the bed, or the administration of the medicines was sufficient to throw the patient into a marked spasm. The pulse became very poor and there was difficulty in swallowing. Active sweating was induced by hot packs. Large amounts of normal salt solution were given subcutaneously and per rectum. The stomach was washed out repeatedly with bicarbonate

of soda, and the patient was well purged. At about 8.30 P.M. of the same date the condition seemed somewhat improved; the respirations were slower, 20 to the minute; pulse rather rapid, and temperature 99.5°. The patient died suddenly at 9.30 P.M.

The urinalysis always revealed a clear urine, a specific gravity of 1015 to 1017, a faintly acid reaction, no sugar, a moderate amount of albumin, no casts.

At the autopsy, performed by Dr. W. G. MacCallum, the following condition was found: The rigor mortis had fixed the extremities in the tetanic position. The lungs showed a beginning bronchopneumonia. The heart was practically normal. On opening the abdomen a most extraordinary picture was presented. A very large, enormously dilated stomach lay obliquely across the abdomen, reaching far into the right flank, but not as low down as appeared on the early clinical examination. There were rather firm adhesions between the pylorus and gall-bladder. The pylorus itself was embedded in a firm scar the appearance of which suggested a healed ulcer. The orifice was very small, barely admitting the point of a probe, and was in marked contrast to the pyloric end of the stomach on the one side and the duodenum on the other. The latter was probably also dilated. Examination of the kidneys revealed a chronic diffuse nephritis.

CASE V. Hyperacidity; dilatation of the stomach (?); tetany.

P. A., aged eighteen years; male; colored. Occupation, janitor. Dispensary No. 71856. Admitted February 20, 1905.¹ He complained of "cramps in the muscles of the shoulders and hands coming from the stomach."

Family History. Negative.

Previous History. Negative.

Present illness began February 2, 1904, with a tingling in the hands, followed by a "drawing up" of the hands and the legs. He tried to walk, but was unable to do so. The condition passed off in about an hour, but recurred in the afternoon and that night, when he had a severe attack associated with very little pain, his hands and feet being both involved, with "contraction of the throat." He states that he lost consciousness and that he was out of his head for several days afterward. Except for indigestion and gaseous eructations he remained well until December, 1904, when, after an error in diet, he had an attack of vomiting and a spasm similar to the one above described. The spasms recurred in January, and again on February 17 and 20, 1905. While waiting for examination he had an attack of cramps in the arms, following which he was very restless, walking to and fro.

Physical examination revealed an intelligent colored youth of good physical condition. There was no speech disturbance. Tapping

¹ This case was kindly sent me by Dr. Thomas from his Nervous Clinic in the Johns Hopkins Hospital University.

over the facial nerve caused contraction of the muscles, associated with a sensation like a pin-prick. A typical Trousseau phenomenon was elicited. With a current of about half a milliampère cathode closure caused a contraction of the arm muscles. If the cathode were placed on any nerve and the current gradually increased, without make or break, the muscles supplied by the nerves were thrown into tetanus. The same condition could be brought out in the face. The knee-kicks were normal. There was no apparent enlargement of the thyroid gland.

On February 23d he returned for examination. On the previous Tuesday and Wednesday night he was awakened repeatedly by tetanic spasm. He had a tingling sensation over the sacrum and shoulders, and, during the attacks, difficulty in micturition, dizziness, vertigo, and pallor. He was very constipated. On examination the facial phenomenon was still present. Pressure over the nerve in the upper arm caused tingling and numbness in the hand, but no spasm. Blood pressure in the left brachial artery was 143 mm.

I first saw the patient on February 25, 1905. A typical history of hypersecretion was then elicited and he was advised to have a test meal. On February 26th he was given an Ewald breakfast, and after one hour 100 c.c. were expressed. The sediment was large in amount, contained no mucus and no blood. Total acidity was 95; total free HCl 71; there was no lactic acid. The microscopic examination was negative, except for some starch and yeast cells. The area of gastric tympany before inflation seemed a trifle increased, reaching just below the navel in the median line, and measuring 27 by 14 cm.; after inflation it did not alter appreciably. There was no visible peristalsis and no palpable tumor.

When last seen the patient had been free from the attacks of tetany for some time.

CASE VI. *Dilatation of stomach; tetany.*

F. K., aged forty-five years; male; white; Irish. Occupation, plumber. Hospital No. 50101. Admitted March 3, 1905. Complaint: "spasms."

Family History. Negative.

Previous History. He had been a large eater and had had indigestion for years. He was habitually constipated. For years he had been a very heavy drinker of beer and whiskey.

Present Illness. On February 11, 1905, he stepped on a nail; next morning his foot was swollen and remained so for four days, but by the end of a week it was perfectly well. On February 19, 1905, he had numbness and a sleeping sensation in his hands, arms, and feet. This gradually got worse and became so marked that he constantly rubbed them for relief. On March 3d at 6 A.M. he first noticed "drawing up" of the fingers of both hands, but more especially of the left. The hands were flexed at the wrist and the forearms at the elbows. This spasm lasted until 9 A.M. At 10 A.M.

he had a second attack, which was more severe, but limited to the left arm; the right arm and both legs were numb. This lasted until 1 P.M. At 5.30 P.M. a third attack occurred, affecting both arms; there was no cramp in the legs, but the face felt numb and the mouth drawn. The pain was very severe in all these attacks, causing him to cry out. Fearing lockjaw he came to the hospital and was admitted at 11 P.M. on March 3d.

Physical Examination. In the waiting-room he was very excited, and in great fear of another attack. There was no trismus or spasm of the muscles of the extremities. There was a well-marked Trousseau symptom in both arms, especially marked on the left side. He cried with pain. There was no Chvostek sign present.

Next morning when I saw him there was no spasm of the muscles and neither Trousseau's nor Chvostek's symptom could be elicited. The tendon reflexes of the upper and lower extremities were diminished. There was no lead-line on the gums. The lungs and heart were normal except for an accentuation of the aortic second sound. The radial artery was palpable. The area of gastric tympany without inflation was moderately increased. A blood count showed: red blood corpuscles, 4,536,000; white blood corpuscles, 5140; hemoglobin, 83 per cent.

On March 9th an Ewald test breakfast gave a residue of 120 c.c., a total acidity of 30, and free HCl 19. Microscopically, it was negative. On this date the area of gastric tympany after inflation extended 4 cm. below the navel in the median line and measured 31 by 14 cm. There was no peristalsis visible. The electric reaction of the ulnar nerves was normal.

The urine contained on one examination a trace of albumin, but no casts. There was slight fever during the first twenty-four hours (101°).

He was discharged well on March 9th, having had no attack while in the hospital.

On May 13th he returned for observation with his physician, Dr. John Girdwood. He had been drinking heavily since his discharge and had had frequent attacks of pain in the stomach with vomiting. He had had numerous attacks of "cramps" in the arms, and Trousseau's sign had been elicited by Dr. Girdwood on several occasions since discharge. At a subsequent visit there were no muscular cramps, and I could obtain neither Trousseau's nor Chvostek's sign.

CASE VII. *Chronic diarrhæa; tetany.*

R. J., aged twenty-four years; male; white. Occupation, lumber inspector. Hospital No. 42003. Admitted March 7, 1903. Complaint, diarrhæa.

Family History. Negative.

Previous History. In 1895 he received a gunshot wound in the left forehead with the "loss of two ounces of brain substance." He

was unconscious for two weeks, during which time he had convulsions. No paralysis followed, but for two or three months he had sensory aphasia. In the summer of 1901 he became subject to dizzy attacks. Average weight, 180 pounds.

Present Illness. Since December, 1902, he had "cramps." The first attack came on as a tingling in the fingers of the left hand as though they were asleep. Then the hand became cramped, with contraction of the flexor muscles and doubling up of the fingers and wrist. In later attacks the cramps sometimes extended to the other arm and even to the feet, calves, and thighs. The legs, however, were not so often attacked as the arms. "Sleepy sensations" had been noticed in the abdomen and chest. In February, 1903, he had his first convulsion, about which he remembered little; he had been told that his face was twisted and that he foamed at the mouth. He had had two or three convulsions since that date. His memory had been poor since the convulsions began. Diarrhœa began in May, 1902, while working in New Orleans and drinking river water. The stools numbered eight a day, were watery, dark in color, but never contained mucus or blood. The appetite had failed somewhat during the few weeks before his admission.

Physical Examination. There was some emaciation (weight 101½ pounds). There was a scar over the left forehead. The left pupil was smaller than the right, but both reacted to light. There was no paralysis of the seventh nerve. There was general muscular atrophy, especially marked in the interossei. There was very slight clubbing of the fingers. Speech was slow and drawling, but not scanning. The thyroid gland was not enlarged. The heart and lungs were normal. The abdomen was somewhat distended, with some general resistance on palpation. The area of gastric tympany was somewhat increased. The knee-jerks were sluggish. The stools were negative for parasites or their eggs. Red blood corpuscles, 4,604,000; white blood corpuscles, 8900; hæmoglobin, 78 per cent. Blood pressure, 120 mm. Hg.

The special examination revealed some constant flexor contraction of the hands and feet. Trousseau's phenomenon was readily elicited in both hands and feet. The facial phenomenon was also present. Dr. H. M. Thomas found marked increase of the electric irritability to galvanism; thus with the cathode pole on any nerve trunk and the current gradually increased from zero, without make or break, the muscles supplied by the nerve were thrown into tetanic contraction. This was tested on March 10th and again on March 23d, when a somewhat stronger current was necessary; thus

	March 10th.	March 23d.
<i>Right ulnar</i>	K. C. C. = 0.8 milliampère.	= 0.7 milliampère.
	A. C. C. = 3.0 "	= 1.7 "
	A. O. C. = 3.0 "	= 4.0 "
	K. C. Te. = 1.0+ "	= 2.0 "

For the first week after his admission there was constantly more or less flexor contraction, with occasional active spasm in the early morning. These by March 16th were much less marked, and the tetany by pressure over the nerve trunks was much less easily induced, less marked in degree, and accompanied by less discomfort. The facial phenomenon varied. The patient's general condition gradually improved, and the diarrhoea ceased entirely by April 1st.

On the night of April 9th the patient was heard to cry out in a peculiar gurgling fashion, and was found in a general convulsion, the eyes rolling, the teeth grinding, the lips contracted, and he was foaming at the mouth. The head was thrown back, and all the limbs were drawn up in a general tetanic spasm, which was quite symmetrical, and lasted one minute. There was no relaxation of the sphincters. After the convulsion he was drowsy and stupid, complaining of headache. Next morning there was some flexion of both hands, and tetanic spasm was readily elicited. A blood count on April 13th revealed: red blood corpuscles 5,165,000; white blood corpuscles, 9000; hæmoglobin, 94 per cent. Gastric analysis on April 21st yielded a residue of 150 c.c., thick and mucoid. The microscopic examination was negative for bacilli and sarcinæ. There was no free HCl and no lactic acid; total acidity, 6.

A note on May 11th stated that he still had from two to four semisolid or formed stools in the twenty-four hours. Trousseau's phenomenon could still be elicited after three or four minutes' pressure. The gastric analysis on May 11th and 13th again revealed marked subacidity.

The urine examination revealed a specific gravity of 1004 to 1013, no sugar, an occasional trace of albumin, but no casts except at the first examination.

The temperature ran a normal course, with but a slight rise on April 30th. His condition gradually improved, he had no further convulsions, and he was discharged well on June 29th, having gained 27 pounds.

A letter from him dated March 23, 1905, stated that he had been free from both diarrhoea and tetany since his discharge and that he felt perfectly well.

CASE VIII. *Tetany; rickets* (?).

R. C. L., aged six months; male; colored. Hospital No. 45548. Admitted February 4, 1904. The history was obtained from the mother. Complaint: "spasms."

Family History. Negative.

Previous History. He was a healthy baby, having been fed on mother's milk until two weeks before admission, when he was given equal parts of boiled cows' milk and water. The bowels were regular.

Present Illness. The child began to fail two weeks before admission. On January 28th the spasms were first noted. They

recurred frequently, there being five on each night of February 2d, 3d, and 6th. The first indication was rolling up of the eyes, then rigidity of all the muscles, with jerking of the hands, and twitching of the legs and the left half of the face. The duration of the spasms was usually half an hour. The child did not cry, but he had incontinence of urine during the seizure. After the spasms he would doze. There had been no vomiting. The bowels had been constipated. There was general muscular tenderness upon handling. The recent spasms were not of such long duration, but were more frequent. There was cough and some loss in weight. On January 29th the diet was regulated, and the bowels freely purged without benefit.

Physical examination revealed a well-nourished though dull and drowsy child. The fontanelles were open. Child was somewhat rachitic. There was dull tympany and tubular breathing over the upper lobe of the right lung. The heart and the abdomen were negative. The arms were rigid and there was fairly marked carpopedal spasm. The knee-jerks were exaggerated. Red blood corpuscles, 4,900,000; white blood corpuscles, 11,600; hæmoglobin, 75 per cent. The differential count was normal.

On February 10th the child was fretful. There had been no convulsions for four days. There was still quite marked tetany of the hands and feet.

On March 7th there was little or no improvement. There was slight rigidity of the neck muscles and some spasm of the hands and feet. Lungs were clear. The eye-grounds were negative. White blood corpuscles, 6300.

On March 11th a lumbar puncture revealed a clear fluid under a pressure of 100 mm. The cultures were negative.

On March 19th the child was removed against advice. There was still marked carpopedal spasm and rigidity of the legs and neck. The hands, though almost constantly contracted and rigid, were occasionally relaxed. During his stay in the hospital there had been slight fever (100°) for three or four days. The pulse ranged from 100 to 120. Respirations were 28. His weight on admission was 14 pounds; on discharge, 12 pounds. He had been taking parathyroid gland for several days before his discharge.

CASE IX. *Gastroenteritis; abscess of the scalp; rickets; tetany.*

A. R., aged three and a half months; female; colored. Hospital No. 46788. Admitted May 19, 1904. The history was obtained from the mother. Complaint: "fast breathing."

Family History. Negative.

Previous History. The patient was born with the aid of forceps. She was breast-fed for one month until she began to suffer from vomiting. She was then fed on oatmeal-water and condensed milk and the digestive trouble ceased. The bowels were regular. She had no infections other than thrush.

Present illness began May 16th with fretfulness followed by repeated vomiting. On May 18th there was an attack in which the eyes rolled back and the head tossed from side to side. There was no general convulsion. This attack was followed in three to four hours by rapid breathing and a slight cough. The bowels were loose (three to four stools in twenty-four hours).

Physical Examination. The child looked ill. Respirations, 70 to 80 to the minute. There were a few small pustules on the neck and left arm. There was a small ulcer with a sharp edge over the right shin. There was also decided evidence of rickets. The thoracic and abdominal viscera were normal. There was flexion of the arms and wrists, with the fingers clenched over the thumbs. There was also carpopedal spasm and slight retraction of the head and rigidity of the neck. The tendon reflexes were normal. Red blood corpuscles, 4,700,000; white blood corpuscles, 8600; hæmoglobin, 50 per cent.

The child improved slightly, but showed evidence of intestinal colic, with frothy, light-green stools, varying in number from two to seven in the twenty-four hours.

On May 27th the temperature, which had been normal, rose rapidly and ranged from 102° to 103°.

On May 30th an abscess of the scalp was found over the mastoid region (white blood corpuscles, 6600). The child was then transferred to the surgical service, where the abscess was evacuated and drained, but no sign of involvement of the underlying bone found.

The child did well for some time and the abscess gradually healed. About the middle of June the eyelids, feet, and shins became œdematous, and the urine was found to contain a trace of albumin, but no casts. There was no note as to the presence of tetany after May 30th. The child died July 7th from asthenia. The autopsy revealed no evidences of meningitis or nephritis.

SUMMARY OF THE AUTHOR'S CASES. Seven cases were in adults, whose ages ranged from eighteen to fifty-eight years, or an average of 38.8 years. These were all males, though the ratio of the admissions to the medical service is two males to one female. There were but 2 cases in children (both six months or under); but it must be borne in mind that these figures give no accurate idea of the frequency of infantile tetany in Baltimore, as the latter, though not infrequent in the pediatric and neurological dispensaries, are rarely admitted to the wards.

The occupation of the adults was very varied, and in only one was it of a specially sedentary nature. They were one laborer, one rattanner, one janitor, one plumber, one manager of a foundry, one lumber inspector, and one merchant.

Four of them had definite dilatation of the stomach, in one case due to pyloric stenosis.

Two others had hyperacidity of the gastric juice without evident

dilatation of the stomach. Hence there were 6 cases of gastric origin.

One case had chronic diarrhœa, which is the only adult case of tetany of purely intestinal origin in the American literature of the past decade.

In the infantile cases, one had slight evidence of rickets and the other had undoubted signs of rickets, as well as an abscess of the scalp and an acute gastroenteritis.

All the seven adults had definite prodromata, while in all the series there was the typical spasm of the muscles, either of the upper extremities alone (2 cases) or of all four extremities (7 cases). In addition, the face was involved in 4 cases, the neck in 2, and the trunk in 1 case. The intensity of the paroxysm was severe in 4, moderate in 3, and mild in 2 cases. The duration of the muscular spasm itself, or the liability thereto, ranged from a few seconds to three months.

The four accessory phenomena were unfortunately not tested in either of the infantile cases or in all of the adult cases. Trousseau's phenomenon was present in 5 of 6 cases examined. Chvostek's sign was positive in 4 of 6 cases tested. Erb's phenomenon was demonstrated in 4 of the 5 cases in which the electric examination was made. Hoffmann's phenomenon was looked for in only 1 case and then without success.

Pain in the affected muscles was a marked feature in 3 cases. In 1 gastric case severe abdominal pain was experienced.

Of the rarer manifestations, fibrillary tremor in the muscles of the hands occurred once; coarse twitchings of the muscles of the arms, once; general epileptic convulsions, delirium, coma, dysuria, anuria, and dysphagia, each in 1 case. In the case of intestinal origin there was clubbing of the fingers.

The tendon reflexes were normal in 3, exaggerated in 2, and diminished in 3 cases. In 1 case they were not tested.

The temperature was normal in 5 cases and slightly elevated in 2. In another case the temperature reached 101°.

The pulse rate was a little above normal in 5 cases, sometimes ranging as high as 100 or more beats a minute.

The urine showed the presence of albumin in 6 of the 7 cases in which this was tested. Casts were found in none. In 1 case the autopsy revealed the presence of a chronic nephritis.

The bowels were loose in 3, constipated in 4, and regular in 2 cases.

The examination of the hæmoglobin and red cells showed a normal count in 2, slight anæmia in 2, and a marked secondary anæmia (50 per cent.) in 1 case.

The leukocytes were normal in 5 cases and increased in 2. In one of the latter the leukocytosis amounted to 17,480 per c.mm., due possibly to the marked stagnation of the gastric contents,

though, as there had been no count made before the onset of the tetanic spasm, it is impossible to say absolutely.

An analysis of the gastric contents showed the constituents to be normal in 2 and subnormal in 1 case. In 3 there was hyperacidity.

Four cases recovered completely; 3 were discharged unimproved, of which 1 died eight months later from asthma; 1 was lost sight of, and 1 is still subject to tetanic cramps. Two died in the hospital, one during the attack of tetany and the other from asthma due to an abscess of the scalp.

All 9 cases received medical treatment.

Let us now briefly discuss the more general features of tetany.

ETIOLOGY. *Historical.* To Dance (1831) and his pupils of the French school is due the earliest and, indeed, the greater part of our knowledge of the disease. Frankl-Hochwart claims that Steinheim, a physician of Altona, gave the first clear description of tetany in 1830 in a short paper entitled "Two Rare Forms of Severe Rheumatism." Lucien Corvisart, in 1852, proposed the name of "tétanie." Trousseau, in 1854, made the most important contribution to the recognition of the disease. Since 1872 the Germans have contributed most to our knowledge.

Incidence. More cases have been reported from Europe than any other continent. In Vienna tetany formed 0.7 per cent. and in Berlin 0.1 per cent. of the neurological clinic. In America it is rare. Griffith¹⁰ was able to collect but 77 cases in American literature up to January 1, 1895. From that date to January 1, 1905, I have found only 23 additional cases in adults and 45 in children. This brings the total of American cases, including our 9, to 154. A glance at the appended tables of reported cases will reveal the more important data of these. We have omitted from this list 23 other cases by reason of the incompleteness of the data, or the probable unsuitability of the diagnosis. Among 18,150 admissions to the medical wards of the Johns Hopkins Hospital there have been but 9 cases of tetany, or 0.05 per cent. Tetany is commonest in winter and spring, especially the months of March and April. Exposure to cold during these months may determine the outbreak of the latent disease.

Age. It is a disease chiefly of infant and young adult life; 60 per cent. occur before the twentieth year. My tables confirm this statement.

Sex. In infancy the male seems more susceptible. Thus, of our 47 cases there were 33 males (70 per cent.). After the twentieth year it is held that the female is more susceptible. In my figures for adults, however, the same proportion as in infancy holds good.

Heredity. There does seem to be a peculiar liability in some families to the disease. Vaughn²⁷ reported, in 1893, 5 cases in one family in New York. In 5 of the infantile cases in my tables (Cases

3, 5, 21, 24, and 45) another member of the family had been affected.

Occupation. Tetany seems more common in the working classes, especially in those pursuing a sedentary occupation. Of 399 cases collected by Frankl-Hochwart, 174 were shoemakers and 95 in tailors. In certain German towns where shoemakers comprise but 1.3 per cent. of the population, 43 per cent. of all the cases were of this class. Unfortunately, the occupation of many of the reported cases was not given, for which reason I have not attempted to report figures on this point.

ETIOLOGICAL CLASSIFICATION. The various conditions with which tetany is associated is best shown by Frankl-Hochwart's classification, which I have adopted. Yet I agree with Strong's⁴ statement that they are groups of convenience, representing frequency of occurrence, which will be ultimately replaced by divisions expressing the etiology.

A. Tetany of Adults. 1. In the first group our authority places the *epidemic tetany* or "idiopathic workman's tetany," or, as more commonly known, "shoemakers' cramp." "In certain parts of the continent of Europe the disease has prevailed widely, particularly in the winter months. Von Jaksch, who has described an epidemic form occurring in young men of the working classes, sometimes with slight fever, regards the disease as infectious. This form is acute, lasting only two or three weeks and rarely proving fatal." (Osler.) Various instances of such epidemics in schools, asylums, and prisons are on record. Thus, in France there were 30 cases in a girls' school, while epidemics have occurred in various Belgian prisons. Vaughn⁷ has reported a series of 7 cases in New York and states that there were several other unrecorded cases in the Italian quarter at the same time. This is the only evidence of the occurrence of the epidemic form in America. Tetany is said to be endemic in Vienna, Prague, and Paris.

2. Tetany also occurs in *gastrointestinal disorders*, as diarrhoea, dyspepsia, gastrectasis, and intestinal worms. Fischl found that 66 per cent. of the cases of tetany were associated with gastrointestinal disorders; Ganzhofner, 81 per cent.; Kirchgasser, 75 per cent.; Cassel, 60 per cent. Hecker¹¹ believes that it is very probable that the intestinal disturbance is not the cause, but merely coincident with tetany, as it would otherwise be difficult to account for the fact that tetany is rare in summer, when intestinal catarrh is most prevalent. In our American series 24 of the 30 adult cases (80 per cent.) and 29 of the 47 infantile cases (61.7 per cent.) were of gastrointestinal origin. That is to say, in the whole series of American cases 68.8 per cent. had a coexisting affection of the gastrointestinal tract.

⁴Gastric tetany forms one of the most characteristic groups. The form in association with dilatation of the stomach was first described

by Kussinaul in 1869. It is not common, as Riegel in his enormous clinic has seen only 4 cases, and was unable to collect more than 23 others. Richartz,²⁰ in 1904, in his careful analysis brought the total number in the literature to 43. We report 4 more. The dilatation, though usually due to cicatricial stenosis from ulcer of the stomach or duodenum, may be due to carcinoma ventriculi, distention of the gall-bladder, or a pancreatic cyst. Hyperacidity and hypersecretion of the gastric juice without evident gastrectasis may also be an etiological factor. Two of our cases were of this nature. Schlesinger, Moynihan and others have reported a chronic benign form of gastric tetany. In gastric tetany severe vomiting, less frequently the passage of the stomach tube or percussion over the stomach, are apt to precipitate an attack. Chronic diarrhoea or chronic constipation also predisposes to this condition. A few cases are on record, notably that of Riegel, in which intestinal worms were the supposed predisposing factor. Hoffmann has reported a case complicating jaundice.

3. Tetany occasionally occurs in the *acute infectious diseases*, as typhoid fever, cholera, influenza, measles, and scarlatina. In certain epidemics of typhoid fever tetany arises during the 'all height of the disease. Osler quotes Janeway* as having reported instances in this country. In cholera it is not unknown. Occasional examples are seen in scarlatina and measles. My tables show few examples of this group. Among the 77 cases there is a history of acute infection in 10. The infection was acute bronchitis and erysipelas in 3 cases each; scarlatina, influenza, pertussis, and otitis media occurred each in 1 case.

4. Tetany may follow poisoning from *chloroform*, *morphine*, *ergot*, *lead*, and *alcohol*. Under this group may also be mentioned tetany in association with the uræmia of chronic nephritis, a few examples of which occur in literature.

5. Tetany of the *pregnant, puerperal, and nursing women*. Trousseau originally described tetany under the name of "nurses' contracture." It may develop for the first time during pregnancy and recur in successive pregnancies. When already present, it may disappear with the onset of pregnancy and reappear in the later months. The onset occurs most commonly during lactation and, secondly, during the latter half of the period of gestation. When the menstruation is established tetany may reappear at each period. It is rare during labor and the puerperium. Dr. H. M. Thomas,²² in 1895, offered the following hypothesis: "The occurrence of tetany during pregnancy depends primarily upon some abnormality in the function of the thyroid gland, and it is the unusual demands made upon this organ in the later months of pregnancy which make this a favorable time for the occurrence of the attacks." Schmid-

* Medical News, December, 1899. This reference has been found since going to press, hence is not included in our analyses.

lechner,²¹ in 1905, reported a case with negative autopsy findings; he could find only 22 cases of tetany of this type in the literature. In America during the past decade there have been 3, possibly 4, cases belonging to this group.

6. *Tetany and Thyroid Deficiency.* Tetany may follow removal of the thyroid gland or, rather, as will be pointed out later, of the parathyroids. In 123 cases of total extirpation of the thyroid collected by Billroth and Wölfler there were 19 cases. In the large series of thyroidectomies at the Johns Hopkins Hospital, tetany has never developed. Tetany has been reported complicating myxoedema by Steinlechner and Joffroy on the Continent, and by James Stewart in America. In the latter's case there was no trace of the thyroid gland. No other cases of this type have been reported in America.

7. Tetany may complicate other *nervous disorders*, as exophthalmic goitre, cerebral and cerebellar tumor and syringomyelia.

There are other occasional causes, as sexual excess, masturbation, traumatism, and insolation.

B. *Tetany in Children.* Tetany occurs frequently in children in association with gastrointestinal disorders, acute infections, and rickets. In girls tetany has occurred at the time of puberty, especially when menstruation was delayed.

In Marseilles Oddo found 4 cases of tetany among 3500 cases under his care. Adams² collected from American literature 49 cases in children under two years. In these the associated condition was gastroenteritis in 21, rickets in 8, sepsis in 3, erysipelas in 2, not stated in 15. In the subsequent 21 cases collected by me there was gastroenteritis in 14 cases, rickets in 4 cases, and sepsis, erysipelas, acute bronchitis, and congenital syphilis each in 1 case. It is but fair to add that 9 more cases had rickets in addition to some other more evident associated condition.

Kassowitz's and Cassel's belief that tetany and laryngismus stridulus are caused by rickets finds its main support in the remarkable coincidence of both diseases, and in the parallelism of symptoms. In the first place there is evidence of rickets in 66 to 94 per cent. of children suffering from tetany or laryngospasm. In the second, the three affections occur in children between three months and three years of age. Finally, there is the frequency of all three during the spring season. But reliable observers from Prague and Gratz point out that only from 0.4 per cent. to 2 per cent. of the cases of rickets are attacked by tetany, and also that it is the mildest and not the severest cases of rickets that are associated with tetany, while, on the other hand, many cases of tetany show no evidence of rickets. Morse,¹⁶ of Boston, does not believe rickets to be a great factor in the production of tetany, for out of 7114 children in his clinic he found 196 cases of rickets, but only 1 of tetany. Rudolph Hecker¹¹ believes that the close connection between tetany

and rickets is due to a factor common to both diseases, namely, the injury to the body by the bad air in the crowded houses of the poor during the winter and spring months.

MORBID ANATOMY. There are but few satisfactory records of postmortem examinations. In these very little has been found. Loos held that there was no definite lesion connected with the disease. It was, therefore, considered a neurosis by many. Weiss believed that tetany is due to an irritable condition of the gray matter of the medulla and spinal cord, which is due in its turn to sympathetic disturbances causing irregularities in the innervation of the bloodvessels of the spinal cord. Schlesinger believed that tetany is a disease of the entire nervous system, some of the symptoms being due to an affection of the peripheral nerves, but that the tetanic spasm and Trousseau's phenomenon are the result of increased excitability of the gray matter of the brain, medulla, and spinal cord. Stasse, Niemayer, and Schultze have found a peripheral neuritis in their cases. Baginsky considered it an affection of the peripheral ends of the nerves, due in some cases to a toxic irritation, especially when associated with disease of the gastrointestinal tract. Tonnellé, Blondeau, Grisolle, Trousseau, and Bouchut found hyperæmia of various portions of the brain and cord and their meninges. Langhans claims to have observed a periarteritis and periplebitis of the bloodvessels of the white commissure, and of the anterior horns of the gray matter of the cervical portion of the spinal cord. Several observers (Bonome, Cervesato, Sarbo, and Ferranini) have found inflammatory changes in the ganglion cells of the anterior horns of the spinal cord and medulla. They state that there is first hyperæmia and swelling, later sclerosis and atrophy of the cells. Recently, R. Peters¹⁹ found at autopsy in 8 cases of tetany an interstitial neuritis affecting the extradural portion of the roots of both the motor and sensory nerves. In Case 5 of our series MacCallum found in the parathyroid glands signs of unusual activity, namely, a great number of karyokinetic figures. The latter is a suggestive lead.

We must conclude, therefore, that pathologists are not all agreed as to the anatomical lesions that occur in tetany.

PATHOGENESIS. As yet we have to content ourselves with mere conjecture as to the pathogenesis of tetany.

Kussmaul formulated the *theory of dehydration*, which supposed a drying of the tissues of the body by the continual withdrawal of the body fluid, and, hence, a predisposition to an irritability and an instability of the nervous system. Dehydration may play an important role in tetany, associated with chronic diarrhœa, hypersecretion, and gastrectasis. It does not account for the other varieties. Kussmaul himself abandoned it, though recently Jürgensen has enthusiastically supported this theory.

The *reflex theory* was advanced by Germain-Sée, and supported

by Berlitzheimer, Müller, and Collier. According to it the spasms are due to irritation of the hypersensitive terminal nerves of the mucous membrane of the stomach, which in turn excite the cells in the brain. This theory is quite untenable on account of many obvious objections. Thus, in the first place, reflex action can be responsible only for *evoking* and not for *generating* tetany; secondly, why is not tetany more common in the numerous severe gastric affections?

The *theory of intoxication* was the next to be advanced. This seems at once more attractive. The intoxication may be *exogenous*, as in the epidemic variety, which in many ways resembles an infectious disease. Carpenter,⁴ in 1894, believed that in all cases of tetany sepsis can be assumed, and quoted cases illustrating his contention. He believed that sepsis resulted in anæmia, which, particularly in infants, in whom the irritability is very great, and the inhibitory centres insufficiently developed, often predisposes to convulsions and other nervous diseases, such as tetany. Further, a condition of unstable equilibrium is set up in the nerve centres, under which very slight influence will reproduce from habit the tetanic spasm.

But, at the best, exogenous intoxication can account for but a small number of the cases. It is rather from the *autogenous intoxication* theory that we can expect most. There are two organs which have been suggested as the site of the production of the toxin, namely, the stomach and the thyroid gland. Let us first discuss what one might call the gastric autointoxication school.

Brieger was one of the first to isolate from the gastric contents of sufferers from tetany a body closely allied to syntonin, which he believed to be capable of producing tetany. Flexner, Ewald, Albu, Jacobsen, Bouveret and Devic have all isolated other toxic bodies from the stomach. Bouveret and Devic,⁵ in a very interesting paper, have shown that permanent hypersecretion in a dilated stomach may result in the development of some toxic substance in the gastric contents. They extracted a substance from the gastric juice in a case of tetany which produced typical spasms when injected into two dogs. The nature of the convulsive substance they were not able to determine, but believed it to be a peptotoxin which, acting with a syntonin, is given new properties by alcohol. The essential factors in the production of this peptotoxin are free hydrochloric acid and alcohol in the presence of peptones. Further, they proved that Brieger's peptotoxin is produced in the course of extraction, and does not exist in the stomach of the patient, which statement they admit may be true of their own peptotoxin. Frankl-Hochwart objects to these experiments of Bouveret and Devic, as he believes their cases were not proven to be gastric tetany, on account of the absence of Trousseau's, Chvostek's and Erb's phenomena. Let us add that Albu, Gumprecht, von Jaksch, Dickson and others have

repeatedly failed to reproduce tetany by injecting into animals *untreated* gastric contents from cases of tetany.

Other supporters of the autogenous intoxication theory advance a disordered thyroid metabolism for consideration. Thus, Dr. H. M. Thomas,²⁵ in 1895, wrote: "I am inclined to entertain the opinion that it is probable that tetany occurring under other conditions (than pregnancy) will in most cases be found to be due to an insufficiency, absolute or relative, in the action of the thyroid gland or like structures. If this be true it may serve to explain why the disease occurs so frequently in certain localities and is so rare in other places." Many observers, among others, Halsted in America, have produced tetany experimentally by complete removal of the thyroid gland. Gley, Vassale, Generali in Europe, and W. G. MacCallum in America, have shown that tetany following extirpation of the thyroid gland in dogs is due not to the loss of the thyroid function but to the coincident removal of the parathyroid glands. When these glands are removed a poison which was formerly neutralized by them acts upon the central nervous system and produces tetany. MacCallum believes that spontaneous tetany is apparently the result of the production of so much of this unknown poison that the normal parathyroids are insufficient to neutralize it. An abnormal activity of the cells of the parathyroid gland in Case 4 of our series is a suggestive finding in confirmation of this theory. Notkin has described a body called thyreoprotein, and Fränkel has isolated from the thyroid a body called thyre-antitoxin, both of which are capable of neutralizing the toxin in the blood of the thyroidectomized animals.

Lastly, Fleiner regards the action of poisonous products of metabolism as of less importance than other factors and incapable of acting without them. These factors are the heightened mechanical and electric irritability of muscles and nerves, and especially the influence of voluntary innervation of the muscles in the presence of a disposition to tetany. In other words, he considers a tetanic spasm as the conversion of a voluntary into an involuntary muscular contraction. He assigns the cause of the heightened mechanical and electric irritability to the old theory of Kussmaul—i. e., dehydration of the body in general, but especially of the muscles, nerves, and the central nervous system. The great objection to Fleiner's theory is that it suffices only as an explanation for the gastric form of tetany.

SYMPTOMATOLOGY. Let us now discuss in detail the various symptoms.

Muscular Cramps. These are the characteristic feature of the disease. The *exciting causes* are overexertion and exhaustion, muscular effort, emotion, sudden changes in temperature, an attack of vomiting or acute diarrhoea, percussion over the stomach, gastric lavage, or pressure on the affected limb. There are usually definite *prodromata*, as numbness, tingling, and formication in the extremities,

which were present in 13 of my series. Occasionally headache, malaise, and mental depression occur. Vomiting was the precursor of the paroxysm in 14 cases.

The spasms have certain definite features. They are bilateral and tonic in character, usually commencing at the periphery and gradually spreading upward until the entire musculature of the body may be involved. The hands are most commonly affected, giving rise to the so-called "obstetrical hand," from the fact that the fingers are flexed at the metacarpophalangeal joints, extended and adducted at the two distal joints, while the thenar and hypothenar eminences are contracted so as to deepen the palm of the hand, and the thumb is strongly flexed across the palm. The hand may then be flexed at the wrist and drawn toward the ulnar side; the forearm semipronated and flexed at the elbow; the arm drawn closely to the side or flexed across the thorax. The muscles of the shoulder girdle are rarely involved. In the lower extremities the feet assume a position of talipes equinovarus, with inversion of the foot, plantar flexion of the tarsus and metatarsus, while the toes are flexed on the sole at the metatarsophalangeal, and extended at the distal joints. In severe cases the leg may be flexed on the thigh and the thigh on the pelvis. All four extremities or only one may be attacked. In my series both the arms and legs were involved in 61 cases, the arms alone in 14, and the legs alone in 2 cases, of which both were children. Occasionally spasm occurs in the muscles of the face, resulting in the "risus sardonicus." This was present in 18 cases. Still more rare is the involvement of the muscles of mastication (trismus), though that this does occur in tetany as well as in tetanus must not be forgotten, as it was present in 10 of my series. Spasm of the muscles of the neck, or of the back, or of both, was present in 24 cases, and in several gave rise to well-marked opisthotonos. The thoracic and abdominal muscles were involved in 6 and 3 cases, respectively. Spasm of the larynx is not uncommon in children (10 cases in my series), and in association with rickets may be the predominating feature. In adults laryngospasm is of grave moment and occurred but twice in 37 cases, of which one recovered and the other died. The tongue and eye muscles may also be involved, as was true of each of 2 cases. In severe cases, as in 3 of my series, the diaphragm itself does not escape. In a few isolated cases the bladder has been attacked. The paroxysm is usually intermittent, though it is sometimes continuous with exacerbations of the spasm. While usually tonic in character it may be clonic at the onset, and in some cases from this fact may be mistaken for epilepsy; though it should be borne in mind that in true epilepsy the tonic stage always precedes the clonic. A general convulsion occurred in 13 cases of my series, of which 9 were children.

Laryngospasm. A few words about this special form of spasm, commonly known as laryngismus stridulus, will not be out of place. Escherich and Loos maintain that laryngospasm has no causal connection with rickets, and is but a special form of tetanic spasm of the respiratory muscles. Escherich found in 300 cases of laryngospasm the symptom-complex of tetany was absent only two or three times. Ganghofner found that 94 per cent. and Fischl 63 per cent. of these cases presented tetany symptoms. Kassowitz and Kalischer deny any relation between tetany and laryngospasm. Cassel found spasm of the glottis only twice in 60 cases of tetany, while in 116 cases of laryngospasm tetany occurred only twice. Further, both Cassel and Kassowitz regard laryngospasm as a nervous symptom of rickets. This great divergence of opinion depends upon the various conceptions by the numerous observers of the features essential for a diagnosis of tetany. Now most are agreed that in the majority of cases laryngismus stridulus is associated with tetany, but also that a certain number of cases of laryngospasm form a special group independent of tetany.

Accessory Phenomena. There are certain accessory phenomena which are more or less characteristic of tetany.

1. *Trousseau's Phenomenon.* Pressure on the nerve trunks and bloodvessels of the affected limb, more especially of the upper extremity, will reproduce a typical spasm. This susceptibility may last some time after the cessation of a tetanic spasm, though it is by no means invariably present. It was positive in 80 per cent. of the 45 cases of my series in which it was tested (positive in 36, doubtful in 3, and negative in 6 cases). It is the first of the accessory symptoms to disappear. In children the phenomenon is not as marked; generally, only adduction of the thumb, curving and adduction of the fingers, and pronation of the hand occur. It is said to be often present in hysteria.

2. *Chvostek's phenomenon* implies increased mechanical irritability of the motor nerves and the muscles. Thus, on tapping the motor nerve supplying the affected muscles the spasm will be reproduced. The so-called "facial phenomenon" may be produced by gentle pressure over the seventh cranial nerve, either at its exit from the stylomastoid foramen or along its extracranial course. Schultze found mere stroking of the face will produce blinking of the eye or drawing up of the angle of the mouth. In my series it was present in but 20 of the 40 cases in which it was tested for (50 per cent.). This facial phenomenon is said to be also found in hysteria, epilepsy, chorea, and other nervous affections.

Escherich in his *Traite des Maladies* describes the "mouth phenomenon" which implies the occurrence, after tapping the corner of the mouth or the upper lip, of a contraction of the orbicularis oris on the opposite side, while at the same time the lips are

brought forward as if for whistling. Thiemich described in 2 cases the labial phenomenon, which is a sudden contraction of the orbicularis oris occurring in the waking child on tapping any part of the upper lip, the mouth being brought forward in a snout-like manner.

3. *Erb's phenomenon* implies increased electric irritability of the motor nerves and muscles to both the interrupted (faradic) and the constant (galvanic) current, but more especially to the latter. It is the most constant phenomenon, and may be demonstrated for weeks after the disappearance of the spasm. Frankl-Hochwart always found increased galvanic irritability, though in my series it occurred in only 12 of the 15 cases tested (80 per cent.). The ulnar nerve is usually the most susceptible to this reaction; the facial nerve rarely so. In health the earliest and greatest response is seen on closure at the cathode pole, while in tetany a prompt contraction is seen at either pole, being practically alike on opening or closing. H. M. Thomas²³ found in his case the rare phenomenon which he called "catelectrotonus tetanus." That is to say, with the cathode on the nerve, when the current was still very weak, often before the galvanometer indicated the passage of any current, one could notice fibrillary contractions in the muscles, and as the current was increased the contractures became more marked and the muscles began to be tetanized; this tetanus continued to increase until all the muscles supplied by the nerve were thrown into a strong, steady spasm, which passed off suddenly if the current were broken, or gradually if it were gradually decreased. If the anode were substituted for the cathode, no such occurrence took place. This contraction has been noticed but once before by von Bechterew. Peters¹⁹ has recently called attention to the "jumping-jack sign." This is brought out by placing the anode on the breast and the cathode on the lower cervical vertebrae; stimulation by a current of 3 to 4 milliamperes will cause the arms to jerk up and out like a child's toy. Further, this author has found that the cerebrospinal fluid is increased, and that after lumbar puncture it is impossible to elicit the "jumping-jack sign," owing to the relief of the pressure in the spinal canal.

4. *Sensory Phenomena.* There is pain during the spasm in severe cases, sometimes of great intensity. Pain or tenderness was present in 43 of the 47 cases where this point was noted. Superficial distress occurs in the form of formication and burning. Paresthesiae also occur as sensations of heat and cold and "pins and needles." Anæsthesia occurs rarely—being present to a slight degree in 2 cases, but to a marked extent in 1 case associated with paraplegia. Optic neuritis has been reported in obscure cases. The sensorium remains clear, as a rule, and loss of consciousness is the exception, though in my series there was delirium in 1 case and unconsciousness in 4 cases.

Hoffmann's phenomenon implies increased irritability of the sensory nerves to both mechanical and electric stimulation. In other words, tapping over a sensory nerve or the passage of an electric current through the affected region will result in paresthesia or even pain. Unfortunately this sign was tested in only 4 cases, but was found present in 3 (75 per cent).

The tendon reflexes are variable, being sometimes increased (13 cases), sometimes diminished (4 cases), or even absent (4 cases), and sometimes normal (13 cases). The epileptiform attacks which are observed in tetany are rightly considered not a mere complication, but as being manifestations of the symptom-complex.

5. The *phrenic phenomenon* was first described in 1902 by Solovieff.²² He observed in 2 cases a drawing in of the lower intercostal spaces of the left half of the thorax with each heart beat. Further, on radioscopic examination the left half of the diaphragm contracted with each heart beat, while the right half contracted only with each respiration. The value of this sign remains to be determined.

Vasomotor and Trophic Phenomena. In the chronic and more rarely in the acute forms of tetany one finds secretory and trophic disturbances. Thus solid edema of the hands or feet with redness of the overlying skin may develop, and either disappear during the paroxysm or persist in the intervals. It was present in 11 cases of my series. Occasionally there is effusion into the tendon sheaths or joints. Flushing of the face (3 cases), injection of the eyes, redness or even marked cyanosis of the ears or hands (4 cases) are not unknown. Sweating (3 cases), dryness of the skin, desquamation (1 case), falling out of the hair or nails are seen. Occasionally one observes erythematous, herpetiform, scarlatinal, morbilliform, and urticarial eruptions. In my series one case showed an erythema, while in another a definite purpura was noted. Pigmentation of the skin also occurs, due possibly to vascular obstruction from spasm of the underlying muscle. Cataract is also seen. Peters believes the latter to be due to obstruction of the circulation in the vessels adjacent to the lens from spasm of the ciliary muscle, and hence to interference with its nutrition.

GENERAL SYMPTOMS. The pulse is often accelerated. There may be rapid breathing or even dyspnea from spasm of the diaphragm. The temperature, though usually normal, may range between 99° and 101°. The pupils, according to Bouveret and Devic, and Cunningham, are contracted during the attack of tetany. Trevilian and Kussmaul have observed widely dilated, immobile pupils during the paroxysm. Transitory blindness has been recorded by Kussmaul, Bouveret, Trevilian, and Cunningham.

The urine varies greatly. Hoffmann, Neuser, Mader and Frankl-Hochwart on the Continent and Locke in America have each

reported a case of polyuria. More usually there is diminution in the amount of urine, if not complete suppression, especially during a severe attack. This occurred twice in my series. Albuminuria, we believe, is frequent during and immediately following the paroxysm, though there may be no evidence of renal disorder postmortem. Albumin was present in 9 of 21 cases in our series where this was noted; 6 of these 9 were cases from the Johns Hopkins Hospital. The presence of albuminuria further suggests the toxic nature of tetany. Among 72 cases of tetany in children examined by Loos, only 2 showed albumin in the urine. Tube casts were found in one case reported by Cunningham.¹⁶ Acetonuria, aceturia, and, more rarely, glycosuria, occur. Indicanuria has been observed by some. Ewald has also isolated a peptotoxin from the urine.

DIAGNOSIS. Anyone conversant with tetany will be at once struck with the manifold and apparently dissimilar conditions with which it may be associated. One is forced to conclude, from a consideration of these, that tetany is not a disease *sui generis*, but rather a symptom complex. Morse,¹⁸ in 1898, wrote: "Like epilepsy tetany must be regarded as a nosological entity and not as a definite disease." Frankl-Hochwart, Fleinert and Ury restrict the term tetany to a condition in which typical muscular spasms exist together with the accessory phenomena of Trousseau, Chvostek, Erb and Hoffmann. Morse and others believe that the only pathognomonic symptom of tetany is the spontaneous, intermittent, muscular contracture. The former states that Trousseau's, Erb's, and Chvostek's phenomena are not pathognomonic of tetany and do not either singly or in combination afford sufficient ground for the diagnosis of the disease, because they are not constantly present and may occur in many other conditions. Frankl-Hochwart, however, recognize, in addition to *true* tetany, incomplete, latent, and so-called tetanoid forms, where spontaneous spasm is absent, but where Trousseau's, Erb's, and Chvostek's phenomena are present. He also recognizes cases with typical muscular spasm without these accessory phenomena. Strong believes that these tetanoid forms are usually in association with some gastric derangement. During the past year we had under observation a neurotic woman, thirty-four years of age (Hosp. No. 48795), who, following severe and persistent nervous vomiting, complained on several occasions of numbness and cramps in her hands. Twice during gastric lavage there was a definite tetanic spasm of the hands and wrists which disappeared after the withdrawal of the tube.

One other patient (Hospital No. 5841), suffering from carcinoma of the pylorus, with vomiting of large quantities of fluid, also complained of cramps in the hands and stiffness in the jaws. Two days after this complaint the muscles of the arms and feet became rigid and drawn up. This spasm lasted for seven to nine minutes

and then disappeared. No Trousseau's phenomenon could be elicited.

DIFFERENTIAL DIAGNOSIS. A typical case of tetany should present no difficulties. Under some circumstances one has to exclude tetanus, hysteria, meningitis, and epilepsy. In *tetanus* the spasms are more continuous and beginning in the masseter muscles spread to the throat and trunk. There is also pyrexia. The course of the disease is progressively downward. Furthermore, a source of infection is often found.

Hysteria may simulate tetany to a remarkable extent. Here, however, the contractures are rarely bilateral. Psychoses of various forms are prominent. Sensory disturbances, transitory paralyses, emotional outbreaks, or optic difficulties are present. Convulsions with more or less loss of consciousness occur. In women ovarian tenderness is also suggestive. Trousseau's phenomenon is usually absent, though Charcot and others state that it may occur in hysterical subjects. We cannot agree with Gilles de la Tourette, Raymond and Murray¹⁸ that nearly all cases of tetany are manifestations of hysteria.

A case illustrating the similarity of hysteria to tetany occurred in the medical service of the Johns Hopkins Hospital (Hosp. No. 40797).

Though possibly it might have been considered tetany by some observers, we have not included it in our series, in view of the well-marked hysterical stigmata present, and the subsequent history of the case.

Meningitis. The character and distribution of the spasm, and the more pronounced general as well as the sensory symptoms, together with the absence of the peculiar excitability of tetany, serve to differentiate spinal meningitis. In children, however, tuberculous meningitis may be misleading. Frankl-Hochwart quotes the case of a four-year-old boy, who, during anæsthesia for an operation for tuberculosis of the knee-joint, developed typical tetany of the hands. Two days later he died of tuberculous meningitis. In the colored wards of the Johns Hopkins Hospital a female child one year old developed, twelve hours before death, general convulsions with typical tetanic spasms of the upper and lower extremities, which were only partially relaxed by chloroform. At the autopsy a tuberculous meningitis was found.

In *epilepsy* of the Jacksonian type the spasm begins always unilaterally, and, if it becomes general, consciousness is lost. The paroxysm is of short duration, and is followed by weakness for a definite period in the muscles first affected.

PROGNOSIS. The outlook is usually good. The chief danger occurs "when the paroxysms are very violent, causing considerable and repeated interference with respiration, with signs of cedema of

the lungs" (Gowers). In children with chronic diarrhoea the mortality is high. In tetany associated with gastrectasis the mortality is still higher, ranging from 60 to 70 per cent. according to the most conservative estimates. Tetany following acute infection, exposure to cold, exhaustion, rickets, and the administration of toxic substances, generally runs a mild course. In the epidemic variety the prognosis is very favorable. Tetany in pregnancy and lactation is scarcely ever serious, and commonly ceases at the birth of the child or after weaning. Tetany excited by labor pains has occasionally led to fatal results. In "surgical tetany" or that following the total extirpation of the thyroid gland, the course may rapidly prove fatal. In Billroth's series of 12 cases, 8 died, 2 became chronic, and 2 recovered.

TREATMENT. The first indication is to correct the predisposing condition, such as the diarrhoea, vomiting, pregnancy, etc. In the gastric variety one should practice frequent lavage with large quantities of warm fluid, either plain water, normal salt solution, or some mild antiseptic, as Condy's fluid or boric acid. Greenfeld recommends a solution consisting of two drachms of sodium phosphate to a pint of water. Purges and emetics also help, while active diaphoresis and diuresis should never be omitted. In the form associated with gastrectasis surgical intervention is certainly indicated. Cunningham* and Warbasse** have collected 9 cases treated surgically, with a mortality of 33.5 per cent., as compared with a mortality of 65 to 70 per cent. in the cases treated by medical means.

The operations of gastrojejunostomy, or pyloroplasty relieve the stagnation of the stomach contents and so prevent further absorption of the toxic substances, whatever they may be.

In the tetany of pregnancy and in any cases associated with thyroid deficiency the exhibition of thyroid extract is indicated. Very remarkable results have been obtained by Bramwell and Gottstein in Europe and Cabot in America, by the use of thyroid extract in tetany other than that of pregnancy. Maestro, after treating three cases in children with raw or slightly cooked thyroid gland, concluded that the method is exceedingly useful, as it always diminished the intensity and the frequency of the attacks and shortened the duration of the disease. Negative results have also been reported.

Vassale had great success with the administration of parathyroid extract in a case of a child with tetany. Beidl, however, in experimental tetany in parathyroidectomized animals, found the use of parathyroid extract only of slight benefit, whereas larger doses of the thyroid gland were followed by surprising results. Dr. H. M. Thomas' case is being fed with parathyroid extract with apparent benefit by Dr. W. G. MacCallum.

For the spasms themselves, absolute rest in bed, cold to the spine, tepid baths, hot packs, opium, bromides, chloral, and other drugs have been tried with little or no result. The administration of chloroform to primary anaesthesia may lessen the severity of the spasm.

LITERATURE.

1. Adams. American Journal of Obstetrics, New York, 1898, vol. xxxvii.
2. Baraky. Medical News, Philadelphia, 1904, vol. lxxxiv.
3. Bouveret et Devic. Rev. de méd., Paris, 1892.
4. Carpenter. Transactions of the Association of American Physicians, 1889, vol. iv.; Journal of the American Medical Association, 1894, vol. xxxiii.
5. Christens. Centralbl. f. allg. Path. u. path. Anat., vol. xvi., No. 3.
6. Cunningham. Annals of Surgery, 1904, vol. xxxix.
7. Fenwick. Transactions of the Clinical Society of London, 1895, vol. xxviii.
8. Frankl-Hochwart. Nothnagel's Spec. Path. u. Therap., XL, Band II.
9. Gordon. American Medicine, 1903, vol. vi.
10. Griffith. THE AMERICAN JOURNAL OF THE MEDICAL SCIENCES, 1895, vol. cix.
11. Hecker. Samml. klin. Vortr., Leipzig, 1903.
12. Jonnesco et Grossman. Bull. acad. de méd., Paris, vol. lxi.
13. Lothrop. Boston Medical and Surgical Journal, 1896, vol. cxxv.
14. Marinesco. Semaine méd., Paris, 1905.
15. Moorhead. Practitioner, London, 1904, vol. lxxiii.
16. Morse. Journal of the American Medical Association, 1898, vol. xxxi.
17. Moynihan. Boston Medical and Surgical Journal, 1903, vol. cxlix.
18. Murray. Medical Record, New York, 1896, vol. xlix.
19. Peters. Deutsches Arch. f. klin. Med., vol. lxxvi.; Russki Vrach, 1904 (abs. Journal of the American Medical Association, 1904, vol. xliii).
20. Richartz. Zeitschr. f. klin. Med. 1904, vol. lxxx.
21. Schmidlechner. Zeitschr. f. Gynäkol., 1905.
22. Solovieff. Russki Vrach, 1902 (abs. Journal of the American Medical Association, 1902, vol. xxxix).
23. Stewart. Transactions of the Association of American Physicians, 1889, vol. iv.
24. Strong. Boston Medical and Surgical Journal, 1902, vol. cxlviii.
25. Thomas. Johns Hopkins Hospital Bulletin, 1895, vol. vi.
26. Thomson. Archives of Pediatrics, 1896, vol. xlii.
27. Vaughn. New York Medical Journal, 1893, vol. lviii.
28. Warbasse. Annals of Surgery, 1904, vol. xl.

ANALYSIS OF THE CASES OF TETANY IN ADULTS IN

+ = positive. -- = negative.

No.	Author and journal.	Sex and age.	Associated disease.	Prodromata.	Muscular spasm.			Trousseau.	Chvostek.	Erb.	Hoffmann.
					Site.	Intensity.	Duration.				
A. With Dilatation of the Stomach.					I. Gastric Tetany.						
1	James. Presb. Hosp. Reports, 1896.	M. 29	Pyloric stenosis.	Abdominal pain, vomiting.	Legs, arms, abdomen, face, and neck.	Severe.	48 hrs.	—	+	0	0
2	Preble. Journ. Amer. Med. Assoc., 1898.	M. 32	Gastroec-tasis.	Vomiting.	Arms and masseters.	Mild.	0	—	—	0	0
3	Ladd. Med. Council, 1901.	M. 29	Gastroec-tasis.	Vomiting.	Arms, legs, abdomen.	Severe.	24 hrs.	0	0	0	0
4	Strong. Bost. Med. and Surg. Journ., 1902.	M. 43	Gastroec-tasis.	Abdominal pain, vomiting.	Arms, legs, face.	Moderate	2 wks.	+	0	0	0
5	Cunningham. Ann. of Surg., 1904.	M. 28	Pyloric stenosis.	Vomiting, numbness, and tingling of hands.	Arms, legs, face.	Severe.	20 mos.	+	+	0	0
6	Warbasse. Ibid., 1904.	M. 33	Gastroec-tasis (slightly)	Vomiting, dizziness, choking.	Legs, arms, face, neck, and back.	Severe.	4 yrs.	0	0	0	0
7	Howard. Case 2.	M. 24	Gastroec-tasis.	Tickling in legs.	Arms, legs, face.	Severe.	3 wks. +	+	+	+	0
8	Ibid. Case 3.	M. 52	Gastroec-tasis.	Faintness and pallor.	Hands and forearms.	Mild.	3 min.	0	0	0	0
9	Ibid. Case 4.	M. 58	Pyloric stenosis.	Numbness, epigastric pain.	Arms, legs, and face.	Severe.	48 hrs.	+	+	0	0
10	Ibid. Case 6.	M. 45	Gastroec-tasis.	Numbness and formication.	Arms and face.	Moderate	3 mos.	+	—	—	—
B. Without Dilatation of the Stomach.											
11	Larrabee. Bost. Med. and Surg. Journ., 1899.	F. 26	Acute gas-tric.	Headache and nausea.	Arms.	Mild.	24 hrs.	+	—	0	0
12	Hill. Col. Med. Journ., 1899.	F. 34	Acute gas-tric.	Numbness and tingling.	Arms, legs, face, and throat.	Moderate	2 hrs.	+	+	0	0
13	Strong. Bost. Med. and Surg. Journ., 1902.	F. 18	Acute gas-tric.	Vomiting and head-ache.	Arms and masseters.	Mild.	3 hrs.	?	+	—	0
14	Einhorn. XXth Cent., 1896.	M. 23	Chronic gas-tric.	Pain in epi-gastrum, restless.	Arms and legs	Moderate	Every week.	0	0	0	0
15	Bundy. Phil. Med. Journ., 1899.	M. 22	Gastric.	Gastric irri-tability.	Arms, legs, face, neck, abdomen, and thorax.	Severe.	4 wks.	+	—	—	0
16	McCahey. Fort Wayne Journ., 1899.	M. 23	Gast. hyper-acidity.	Aching pain.	Legs and hands.	Severe.	4 wks.	?	0	0	0
17	Hunter. Stylus, 1900.	F. 40	Gastric.	Aching and swelling of joints.	Hands, feet, trunk, dia-phragm, and masseters.	Severe.	7 yrs.	0	0	0	0

¹ Reports of 17 cases by the following authors were not included by reason of the incompleteness of data, no data; 3 cases by Turck in 1898 (no data); 1 case by Wilson in 1899 (no data); 3 cases by Strong in 1902 total to 47 cases of adult tetany.

AMERICA FROM JANUARY 1, 1895, TO JANUARY 1, 1905.¹

0 = not stated. ? = doubtful.

Sensory phenomena.	Unusual phenomena.	Reflexes.	Temp. (° F.), pulse, resp.	Urine.	Bowels.	Result.	Remarks.
A. With Dilatation of the Stomach.				I. Gastric Tetany.			
Pain.	Cyanosis, motor aphasia, fibrillary contraction of muscles, trismus, risus sardonius, opisthotonos.	Normal.	T. 101-105 P. 120-140 R. 24	0	Constipation.	Death.	Previous attack 6 months ago; acute nephritis at autopsy.
0	0	Exaggerated.	T. 101	Normal.	Diarrhea	0	Pulmonic hypertrophic osteoarthropathy also present.
0	0	0	T. 100	0	0	Death.	Death after second attack; at autopsy perforation of cardia.
0	0	0	0	0	Constipation.	Well.	Gastric analysis showed T. a. 0.21, HCl 0.0563 per cent.
Pain.	Unconscious, trismus, motor aphasia, poor vision, contraction of pupils.	Exaggerated.	T. 99 P. 100-126	Albumin and casts.	Constipation.	"	T. a. 0.3, HCl 0.18 per ct., hb. 60 per ct., r. b. c. 4,900,000, w. b. c. 9,000; spasm induced by lavage; post. gastroenterostomy.
No pain.	Unconscious, convulsions, spasm of glottis.	0	0	0	0	"	Foreign bodies in stomach; gastrotomy twice.
0	Fibrillary muscular tremors in hands.	Normal.	T. 98½ P. 88-92	Trace of albumin.	Diarrhea	Unimproved.	with eight months later from thenia; hb. 30 per ct., r. b. c. 4,450,000, w. b. c. 3,600, T. a. 56, HCl 21.
0	Twitching of arms.	0	T. 98½ P. 68-90	Trace of albumin.	Constipation.	Well.	T. a. 66, HCl 54; one attack during removal of test meal.
Agonizing pain.	Stupor, anuria, dysphagia.	Exaggerated.	T. 90.5 P. 76-104 R. 20-24	Moderate albumin.	Regular.	Death.	Marked stagnation of gastric contents; T. a. 40, HCl 10, hb. 70 per ct., r. b. c. 4,656,000, w. b. c. 17,480; at autopsy ch. nephritis.
Severe pain.	0	Diminished.	T. 101 P. 68-96	Trace of albumin.	Constipation.	Unimproved.	Hb. 83 per ct., r. b. c. 4,536,000, w. b. c. 5,140, T. a. 30, HCl 19; slight retention of gast. contents.
B. Without Dilatation of the Stomach.							
Severe pain and prickling.	Syncope.	0	Normal.	0	Regular.	Well.	Tetany followed a dietetic error.
Pain.	Congestion of face.	0	Normal.	0	0	"	Symptoms of hyperacidity and possibly gastric ulcer.
Hyperesthesia.	0	Normal.	T. 99.8	0	0	"	Fatigue factor present.
0	Trismus, alternating with epileptiform convul.	0	0	0	0	Im-proved.	HCl diminished.
Pain, itching of skin.	"Claw hand" at times.	Normal.	0	0	0	Well.	For five years had attacks of tetany of two to three days' duration.
Pain, paraplegia, and anesthesia at onset.	"Claw hand"	Exaggerated.	P. 108	Normal.	Regular.	"	T. a. 90, HCl 40; hysteria possibly.
Pain.	Opisthotonos, trismus, redness of face.	0	T. 100.5	Albumin.	Constipation.	"	Occurred twice in pregnancy; attack began at sixth month.

or the probable unsuitability of the diagnosis: 3 cases by Murray in 1896 (hysteria); 1 case by Lloyd in 1897 (no data); 5 cases by Brown in 1902 (no data); 1 case by Gordon in 1903 (hysteria). These would bring the

No.	Author and Journal.	Sex. and age.	Associated disease.	Prodromata.	Muscular spasm.			Trousseau.	Chvostek.	Erb.	Hoffmann.
					Site.	Intensity.	Duration.				
B. Without Dilatation of the Stomach.											
18	Morgan. Phil. Med. Journ., 1901.	M. 40	Gast. hyper-acidity.	Vomiting and lassitude	Arms.	Severe.	7 yrs.	0	0	0	0
19	Morgan. Ibid.	F. 60	Gast. hyper-acidity.	Gastric distress and weariness.	Arms and neck.	Moderate	8-10 mos.	0	0	0	0
20	Howard. Case 1.	M. 46	Gast. hyper-acidity.	Vomiting.	Hands, feet, face, and limbs.	Severe.	3 mos.	—	—	+	0
21	Ibid. Case 5.	M. color. 18	Gast. hyper-acidity.	Tingling in hands.	Hands and feet.	Moderate	3 wks. +	+	+	+	0

II. Intestinal Tetany.

22	Ibid. Case 7.	M. 23	Chronic diarrhoea.	Tingling in fingers.	Arms, legs, and neck.	Severe.	6 mos.	+	+	+	0
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III. Gastrointestinal Tetany.

23	Strong. Bost. Med. and Surg. Journ., 1902.	M. 44	Gastro-enteritis.	0	Arms and jaws.	Mild.	0	0	0	0	0
24	Brown. Med. News, 1902.	M. 29	Gastro-enteritis.	Colic and nausea.	Legs, arms, and trunk.	Mild.	3-4 wks.	0	+	0	0

IV. Tetany of Pregnancy and Lactation.

25	Thomas. Johns Hopkins Hosp. Bull., 1895.	F. 33	Pregnancy, para vii.	Fatigue and aching.	All muscles, face, and larynx.	Severe.	12 yrs.	+	+	+	0
26	Lothrop. Bost. Med. and Surg. Journ., 1896.	F. 30	Pregnancy, para iv.	Numbness and pricking of hands, nervousness.	Arms, legs, and face.	Severe.	10 wks.	+	+	+	+
27	Bundy. Journ. Nerv. and Ment. Dis., 1899.	F. 32	Lactation, para iii.	0	Arms.	Slight	3 mos.	+	+	+	+

V. Unclassified Tetany.

28	Park. New York Med. Journ., 1896.	F. 57	Lactation, pertussis.	Cramp in arms, spasm of glottis.	Legs, arms, back, jaw, glottis, diaphragm.	Severe.	2 mos.	0	0	+	0
29	Smith. Phil. Med. Journ., 1899.	M. 21	Sudden exertion.	"Oppression."	Arms, legs, abdomen, tongue.	Severe.	20 min.	0	0	0	+
30	Locke. Bost. Med. and Surg. Journ., 1902.	M. 33	Alcohol, exertion, exposure.	Numbness, vomiting and micturition.	Arms, legs, rt. st. mast.	Severe.	23 hrs.	+	0	0	0

Sensory phenomena.	Unusual phenomena.	Reflexes.	Temp. (° F.), pulse, resp.	Urine.	Bowels.	Result.	Remarks.
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B. Without Dilatation of the Stomach.

Intense pain.	Muscular twitchings.	0	0	Normal.	0	Well.	Recurring attacks for 7 years; occasional unconsciousness. Complicated by epilepsy; tetany once after lavage.
Pain.	Swelling of muscles of neck.	Normal.	T. 99.8 P. 60	0	Regular.	"	
Pain, mental excitement.	Pain in abdomen.	Diminished.	T. 98-100 P. 76-120	Normal.	Constipation.	"	Hypersecretion; gastric ulcer(?); T. a. 70, HCl 65, hb. 95 per ct., r. b. c. 5,516,000, w. b. c. 9,000.
No pain; dizziness, vertigo.	Delirium, dysuria.	Normal.	0	0	Constipation.	"	Gastrectasis(?); T. a. 95, HCl 71; no enlargement of thyroid.

II. Intestinal Tetany.

0	Convulsions.	k. k. sluggish.	Normal.	Trace of albumin.	Diarrhoea.	Well.	Clubbing of fingers, no goitre, marked subacidity of gastric juice; hb. 78-94 per ct., r. b. c. 5,165,000, w. b. c. 9,000; gunshot wound of head eight years previous.
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III. Gastrointestinal Tetany.

Weakness and stiffness of hands and legs.	0	0	0	0	Diarrhoea.	0	Russian; gastric tympanum one inch below navel.
Pain, slight anaesthesia.	0	0	0	0	Diarrhoea.	Well.	

IV. Tetany of Pregnancy and Lactation.

Intense pain.	Cyanosis and swelling of hands, fibrillary contract. orb. path.	Exaggerated.	T. norm. P. 76-104	Normal.	Normal.	Well.	Occurred in last half of six pregnancies.
Pain and hyperaesthesia.	Flushing, sweating, and fibrillary twitching of face.	Absent.	T. 100½ P. norm.	Normal.	Constipation.	"	Tetany two hours one year ago; now seven months pregnant; cessation after labor.
0	0	0	0	0	0	0	Italian; first attack 7 years ago; occur every spring, especially at lactation.

V. Unclassified Tetany.

Pain.	Cyanosis, hiccough, spasm of diaphragm, trismus, opisthotonos.	0	0	0	0	Well.	Patient had chronic endometritis; under severe nervous strain; tetany at succeeding menses.
0	Cyanosis, dyspnoea, motor-apnoea.	0	0	0	0	"	
Tingling and numbness, slight anaesthesia.	Cyanosis, sweat.	0	0	Polyuria.	0	"	Prolonged exertion in cold and wet; three attacks in seven years.

ANALYSIS OF THE CASES OF TETANY IN CHILDREN IN
+ = positive. — = negative.

	Author and Journal.	Sex and age.	Associated disease.	Prodromata.	Muscular spasm.			Trousseau.	Chvostek.	Erb.	Hoffmann.
					Site.	Intensity.	Duration.				
1	Preston. New York Med. Jour., 1895.	F. 3½ yrs.	-----	0	Arms and legs.	Slight.	2 yrs.	+	0	0	0
2	Lewi. Arch. of Pediatrics, 1895.	M. 9 mos.	Rickets.	Convulsions.	Hands and feet.	Mild.	3 wks.	0	0	0	0
3	Lewi. Ibid.	M. 8 mos.	Intestinal (?) rickets.	Irritability and constipation.	Hands and feet.	Severe.	10 wks.	0	0	+	0
4	Lewi. Ibid.	M. 8 mos.	Gastro-intestinal (?) rickets.	Irritability and vomiting.	Hands and feet.	Mild.	14 dys.	0	0	+	0
5	Lewi. Ibid.	M. 13 mos.	Gastro-intestinal (?) rickets.	Fever, vomiting, laryng. stridor.	Hands and feet.	Mild.	14 dys.	0	0	0	0
6	Crandall. Ibid., 1895.	M. 6 mos.	Bronchitis, rickets.	Twitching, staring of eyes.	Arms, legs, face, and neck.	Severe.	4 wks.	0	0	0	0
7	Crandall. Ibid.	M. 12 mos.	Gastro-intestinal (?) rickets.	Laryng. stridor.	Arms, legs, face, and larynx.	Severe.	5 wks. (?)	0	0	0	0
8	Lothrop. Bost. Med. and Surg. Journ., 1896.	M. 3 yrs.	Gastro-intestinal.	Vomiting.	Arms and legs.	Moderate.	3 wks.	+	+	0	0
9	Lothrop. Ibid.	M. 18 mos.	Sup. otitis media, rickets.	0	Hands and feet.	Moderate.	Few mos.	?	+	0	0
10	Krauss. Med. Record, 1896.	M. 6 mos.	Gastro-intestinal, dentition.	None.	Arms, legs, face, and diaphragm.	Severe.	5 wks.	+	0	0	0
11	Krauss. Ibid.	M. 18 mos.	Gastro-intestinal, bronchitis.	0	Hands and feet.	Mild.	1 wk.	0	0	0	0
12	Krauss. Ibid.	M. 13 mos.	Gastro-intestinal, bronchitis.	0	Hands and feet.	Mild.	6 dys.	0	0	0	0
13	Krauss. Ibid.	F. 9 mos.	Gastro-intestinal, bronchitis.	0	Hands and feet.	Mild.	3 wks.	0	0	0	0
14	Krauss. Ibid.	F. 11 mos.	Gastro-intestinal, bronchitis, dentition.	0	Hands and feet.	Moderate.	2 wks.	0	0	0	0
15	James. Presb. Hosp. Rep., 1896.	F. 6 yrs.	Gastro-intestinal.	0	Arms, legs, jaw, abdomen.	Moderate.	2½ mos.	+	0	0	0
16	Ferguson. Pediatrics, 1896.	M. 10 mos.	Phimosia.	0	Arms and legs.	Slight.	Several months.	0	0	0	0
17	Ferguson. Ibid.	M. 18 mos.	Gastro-intestinal.	0	Hands, feet, jaws, orb. oris.	Slight.	1 wk.	—	0	0	0
18	McConnell. Canada Med. Record, 1896.	M. 5½ yrs.	Scarlet fever.	0	Legs and arms.	Moderate.	1 wk.	+	+	0	0
19	Morse. Journ. Amer. Med. Assoc., 1898.	F. 4 mos.	Intestinal, mastoiditis.	0	Hands and arms.	Slight.	0	+	—	0	0
20	Morse. Ibid.	F. 4 mos.	Intestinal.	0	Hands and arms.	Slight.	0	+	—	0	0
21	Morse. Ibid.	F. 10 mos.	Rickets.	0	Hands, arms, and larynx.	Moderate.	4½ wks.	—	+	0	0
22	Morse. Ibid.	M. 6 mos.	Gastric.	Vomiting.	Hands and feet.	Moderate.	1 mo.	+	?	0	0
23	Morse. Ibid.	M. 4 mos.	Gastro-intestinal.	0	Arms, legs, and neck.	Slight.	4 mos.	+	—	0	0

¹ Reports of 6 cases by the following authors were not introduced by reason of the incompleteness of data (no data): 1 case by Sailer in 1899 (no data); 1 case by Hand in 1900 (no data); 1 case by Hanna in 1902 (no

AMERICA FROM JANUARY 1, 1895, TO JANUARY 1, 1905.¹

0 = not stated. † = doubtful.

Sensory phenomena.	Unusual phenomena.	Reflexes.	Temp. (° F.), pulse, resp.	Urine.	Bowels.	Result.	Remarks.
No pain.	0	Normal	0	0	Normal.	0	No known cause; periodically she has 15 attacks daily.
Tenderness of hands and feet.	0	0	0	Normal.	Regular	Well	No gastrointestinal disturbance.
Tenderness of hands and feet.	Convulsion and death.	0	0	0	Diarrhoea and constipation.	Death	Two mild attacks; third severe; mild anemia; one other child in the family had tetany, History of vomiting.
Tenderness of hands and feet.	Edema of hands and feet.	0	0	0	Constipation.	Well	
Tenderness of hands and feet.	Edema, erythema, laryngismus.	0	Fever.	0	Constipation.	"	One other child in the family had tetany at one year.
Slight pain.	Convulsive movements, dyspnoea.	0	Normal.	Normal.	Diarrhoea and constipation.	"	Stools showed "intestinal fermentation."
0	Laryngismus, trismus, convulsions.	0	0	0	Diarrhoea and constipation.	"	History of vomiting.
Pain and tenderness.	0	†	T. 100.5 P. 130 R. 29	0	Constipation.	"	
0	None.	0	0	0	0	?	Child lost sight of.
Pain.	Risus sardonius, edema and sweat of face and hands.	0	0	0	Diarrhoea and constipation.	Well	
0	0	0	0	0	Diarrhoea	"	
0	0	0	0	0	Diarrhoea	"	
0	0	0	0	0	0	"	Death four weeks later from meningitis without tetany.
0	0	0	0	0	Diarrhoea	"	
Pain.	Stupor, sweating, scaling of skin.	Exaggerated.	T. 100-104 P. 100 R. 40	0	0	"	
Pain.	Edema of hands.	0	Fever.	Normal.	0	"	Neurotic diathesis; tetany was not benefited by circumcision.
Pain and tenderness.	Trismus, involvement of eye muscles.	0	T. 101	0	Diarrhoea	"	
Pain, tenderness & hyperaesthesia.	Swelling and redness of ankles and wrists.	0	T. 101	Trace albumin.	0	"	Severe angina; tetany 14 days after onset; 1 prior attack at 1½ yrs.
Tenderness	0	Exaggerated.	Normal.	0	Diarrhoea	0	No rickets.
No tenderness.	0	0	0	0	Diarrhoea	Well	No rickets; abdominal pain.
0	Laryngismus, cyanosis.	Normal.	0	0	Normal.	"	Another child also had tetany.
Pain.	0	Normal.	T. 100	Diminished.	Normal.	"	Gastritis; phimosia.
Pain and tenderness.	Convulsions, laryngismus.	Exaggerated.	0	0	Diarrhoea	"	Vomiting, snuffles, and phimosia; no rickets.

or the probable unsuitability of the diagnosis: 1 case by Miles in 1896 (tetanus); 1 case by Reisman in 1899 (data); and 1 case by Barsky in 1904 (no data). These would bring the total to 53 cases of tetany in children.

No.	Author and journal.	Sex and age.	Associated disease.	Prodromata.	Muscular spasm			Trousseau.	Chvostek.	Erb.	Hoffmann.
					Site.	Intensity.	Duration.				
24	Morse. Ibid.	M. 10 ½ mos.	Gastro-Intestinal.	0	Arms, legs, neck, and back.	Severe.	10 mos.	+	—	0	0
25	Adams. Amer. Journ. Obstet., 1899.	M. 2 days.	Traumatism.	0	Hands and feet.	Severe.	5 dys.	0	0	0	0
26	Adams. Ibid.	M. 5 mos.	Erysipelas.	0	Hands.	Moderate	48 hrs.	0	0	0	0
27	Varros. Chicago Med. Rec., 1898.	M. 16 mos.	Rickets.	0	Arms, legs, face, and left sternomastoid.	Moderate	3 mos. +	+	+	+	0
28	Davis. Ibid.	M. 15 mos.	Intestinal, rickets.	0	Hands and feet.	Slight.	3 mos.	0	0	0	0
29	Davis. Ibid.	M. 8 mos.	Intestinal, bronchitis, rickets.	0	Hands.	Slight.	3 mos.	0	0	0	0
30	Davis. Ibid.	M. 18 mos.	Intestinal, pneumonia	0	Legs, abdomen, and thorax.	Slight.	0	0	0	0	0
31	Hubbard. Bost. Med. and Surg. Journ., 1899.	M. 14 mos.	Intestinal, abscess.	0	Hands, feet, neck, and back.	Slight.	6 dys.	0	0	0	0
32	White. Ibid.	M. 3 ½ mos.	Rickets, coxa vara.	None.	Legs and feet.	Slight.	10 dys.	+	—	+	0
33	Morse. Ibid.	M. 7 mos.	Gastro-Intestinal, rickets.	0	Hands and feet.	Moderate	1 mo.	+	—	0	0
34	Morse. Ibid.	F. 7 ½ mos.	Rickets.	0	0	Moderate	3 mos.	+	—	0	0
35	Morse. Phila. Med. Journ., 1901.	M. 1 mo.	Gastro-Intestinal.	0	Arms and hands.	Slight.	2 wks.	—	—	0	0
36	Morse. Ibid.	M. 11 mos.	Gastro-Intestinal, rickets.	0	Hands, feet, and back.	Severe.	24 hrs.	+	—	0	0
37	Morse. Ibid.	F. 8 mos.	Gastro-Intestinal, rickets.	0	Hands and feet.	Moderate	7 dys. +	+	—	0	0
38	Morse. Ibid.	F. 11 mos.	Dentition.	Shaking of head.	Hands.	Slight.	14 dys.	+	—	0	0
39	Morse. Ibid.	M. 10 mos.	Otitis med., rickets.	0	Hands, feet, and trunk.	Severe.	7 dys.	+	—	0	0
40	Morse. Ibid.	M. 14 mos.	Gastro-Intestinal, influenza.	0	Arms and feet.	Slight.	24 hrs. +	0	+	0	0
41	Morse. Ibid.	M. 7 mos.	Congenital syphilis, rickets.	Vomiting.	Hands and feet.	Moderate	3 mos.	+	—	0	0
42	McAllister. Arch. of Pediatrics, 1902.	F. 5 yrs.	Gastric.	0	Arms, legs, jaws, face, and back.	Moderate	6 wks.	+	0	0	0
43	Ellerich. Ibid., 1903.	M. 14 mos.	Chronic enteritis.	0	Hands and feet.	Moderate	1 wk.	0	+	0	0
44	Masland. Amer. Med., 1903.	F. 2 ½ mos.	Intestinal, rickets.	Anorexia and languor.	Hands and feet.	Slight.	2 wks.	+	—	0	0
45	Baraky. Med. News, 1904.	F. 11 mos.	Acute bronchitis.	0	Arms and legs.	Moderate	Once.	+	+	0	0
46	Howard.	M. 6 mos.	Rickets (?)	Convulsions.	Arms and legs.	Moderate	15 dys. +	0	0	0	0
47	Howard.	F. 3 ½ mos.	Gastro-Intestinal, rickets, abs. of scalp	Vomiting.	Arms, legs, and neck.	Slight.	10 dys.	0	0	0	0

Sensory phenomena.	Unusual phenomena.	Reflexes.	Temp. (° F.), pulse, resp.	Urine.	Bowels.	Result.	Remarks.
Pain and tenderness.	Opisthotonos, respiratory spasm.	Normal.	T. 99-100	0	Constipation.	Well	Vomiting; two other children died with tetany (?).
Pain.	0	0	0	0	0	"	Forceps delivery; circumcision and secondary hemorrhage.
Pain.	Convulsions.	0	0	0	0	"	Death 6 days later from pneumonia; no meningitis at postmortem.
Pain.	Laryngismus, sweating.	Exaggerated.	0	0	Constipation.	Unimproved	Measles three months before.
0	Laryngismus.	0	Normal.	0	Regular	Well	Italian child; stools partly with undigested food.
0	0	0	0	0	Regular	"	Italian child; stools dark and offensive.
Restlessness.	0	0	T. 102	Normal.	Regular	"	Death ten months later from "convulsions."
0	0	Absent.	0	0	Diarrhoea	"	Rickets; phimosis.
Tenderness.	None.	Exaggerated.	Normal.	Normal.	Regular	"	Italian.
Pain.	Edema of feet and hands, laryngismus.	Normal.	T. 100-101	Normal.	Diarrhoea	"	
0	Edema of hands, convulsions, laryngismus.	Feeble.	0	0	Constipation.	0	
Pain.	0	Normal.	0	0	Diarrhoea	Well	
Pain.	Opisthotonos, purpura.	0	T. 39° C.	0	Diarrhoea	Death	
Pain.	0	0	T. 40° C.	0	Diarrhoea	?	Vomiting; mucus in stools and stomach washings.
0	Swelling of face, convulsions.	0	0	0	Normal	Well	
Pain.	Swelling of arms and legs.	0	T. 40° C.	0	Normal	Death	
0	Convulsions.	Absent.	T. 99	0	Diarrhoea	0	Dentition.
Pain.	Convulsions, laryngeal stridor.	Absent.	0	0	Diarrhoea	Well	
Vertigo, irritability, tenderness, cold pains.	Cyanosis, trismus, unconscious.	Exaggerated.	T. 100.4 P. 120	0	Regular	"	Patient had been vaccinated, but had first attack one month before.
Pain.	Laryngospasm.	0	0	0	Diarrhoea	"	
Pain.	Swelling of hands and feet, anuria 20 hours.	Slightly increased	T. 98½ P. 120	0	Diarrhoea	"	Patient was a colored child; thyroid not enlarged; brother had tetany.
0	0	0	T. 102 P. & R. rapid	0	0	"	Tetany at onset of bronchitis.
Tenderness.	0	Exaggerated.	T. 100 P. 100-120 R. 23	0	Normal.	Unimproved	Colored child, lost eight of; hb. 75; r.b.c. 900,000; w.b.c. 11,600 to 6000.
0	0	Normal.	Normal.	Trace albumin.	Diarrhoea	Death	Colored child; hb. 50 g; r.b.c. 4,700,000; w.b.c. 8,600; death from asthma; autopsy neg.